

SQUIRT-GUNS, SYRINGES AND SCIENCE: PRECISE JET DELIVERY OF LIQUID DRUG USING SERVO-CONTROLLED LINEAR LORENTZ-FORCE ACTUATORS

Andrew J. Taberner, N. Cathy Hogan, and Ian W. Hunter
BioInstrumentation Laboratory,
Department of Mechanical Engineering,
Massachusetts Institute of Technology
Cambridge, Massachusetts, USA
<http://bioinstrumentation.mit.edu>

INTRODUCTION

Transdermal delivery of a liquid drug can be effected without the use of needles by pressurizing the drug and passing it through a narrow orifice, thereby creating a high velocity jet that is capable of penetrating through the outer layers of skin into underlying tissues. Conventional jet injection devices employ energy storage and release techniques (compressed springs and gases) that offer very limited control over the rate and extent of energy delivery, thereby restricting the accuracy and repeatability of drug penetration depth and injected volume.

The BioInstrumentation Laboratory at Massachusetts Institute of Technology has developed a suite of precisely controllable jet drug delivery devices based on novel linear Lorentz force actuator technology (Figure 1).

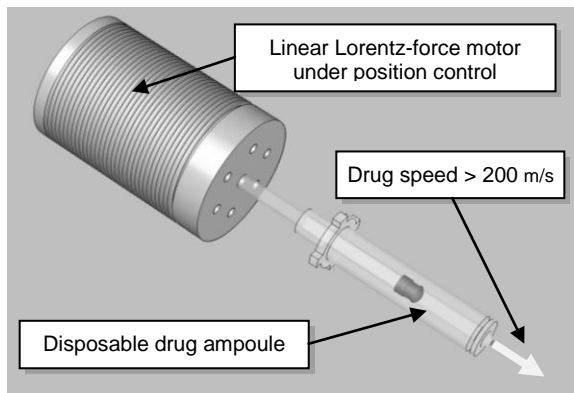


FIGURE 1. Jet injection using a Lorentz-force actuator

Through a combination of careful modeling, measurement, analysis, design and construction we have developed portable and bench-based jet injectors (Figure 2) that are powerful, compact and adaptable to a wide range of

injection requirements. The inherent reversibility and controllability of our Lorentz force motors allow the speed of jet ejection together with the delivered volume to be monitored and regulated throughout the time-course of injection, offering an unprecedented level of flexibility and control over jet injection performance.



FIGURE 2. Portable jet injectors

We have used our jet injection devices to successfully deliver a range of different drugs, including a blend of relatively high molecular weight enzymes to the dermis of a live animal. Physical, biochemical, histological and/or immunological analyses have demonstrated that

drugs when delivered using our devices had activity comparable to, if not better than, drug delivered via needle using a conventional syringe.

We will discuss the challenges and advantages presented by this new form of jet injector, and the methodologies employed to develop our devices and monitor and enhance their performance.